Processing of (BaSr)Fe12O19 for antenna miniaturization

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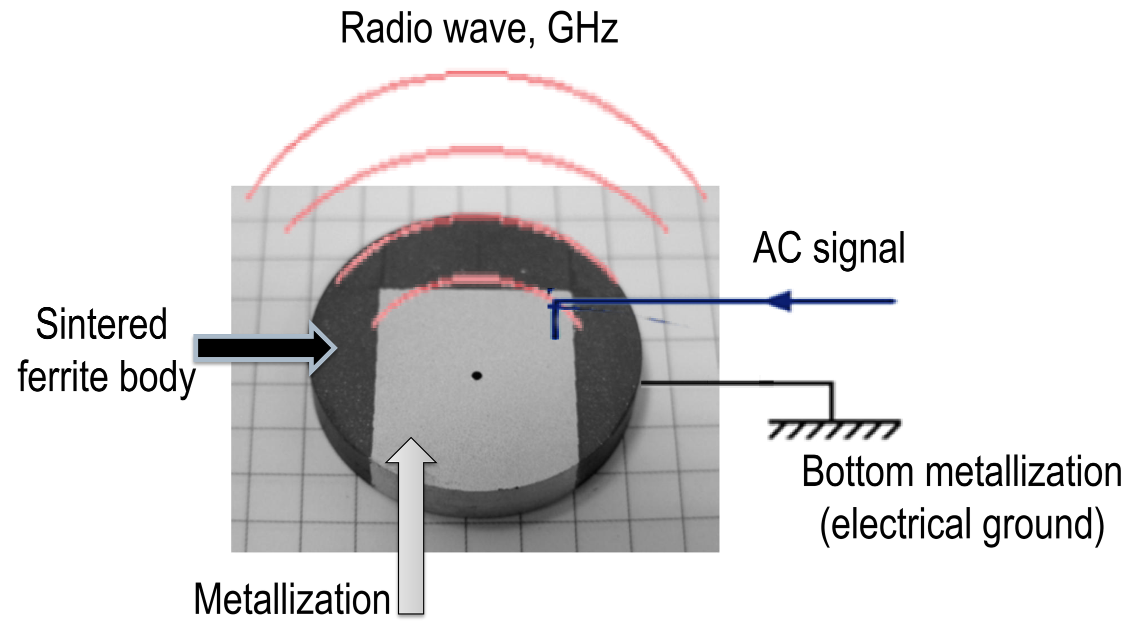
Abstract

Hexaferrites of M-type at high-frequency are investigated, owing to their higher ferro-magnetic resonances as compared to traditional magnetic materials, thus ensuring a less dispersive behavior of the material at microwaves frequencies. Here we present the experimental work concerned with the ceramic process for the production of the barium-strontium hexaferrite (BSFO). The critical issue in the production of this material is to obtain a fully dense and homogeneous microstructure. These aspects have been addressed by introducing powder grinding processes, and by varying the cold consolidation conditions of the powders. A number of samples of the material have been produced, both for morphological and microstructural characterization and a demonstrator antenna, onto which conductive patches were applied, and the radiating properties of which were tested. Barium-strontium hexaferrite as supporting material for antennas - while allowing substantial device miniaturization – displays relatively high dielectric and magnetic losses.

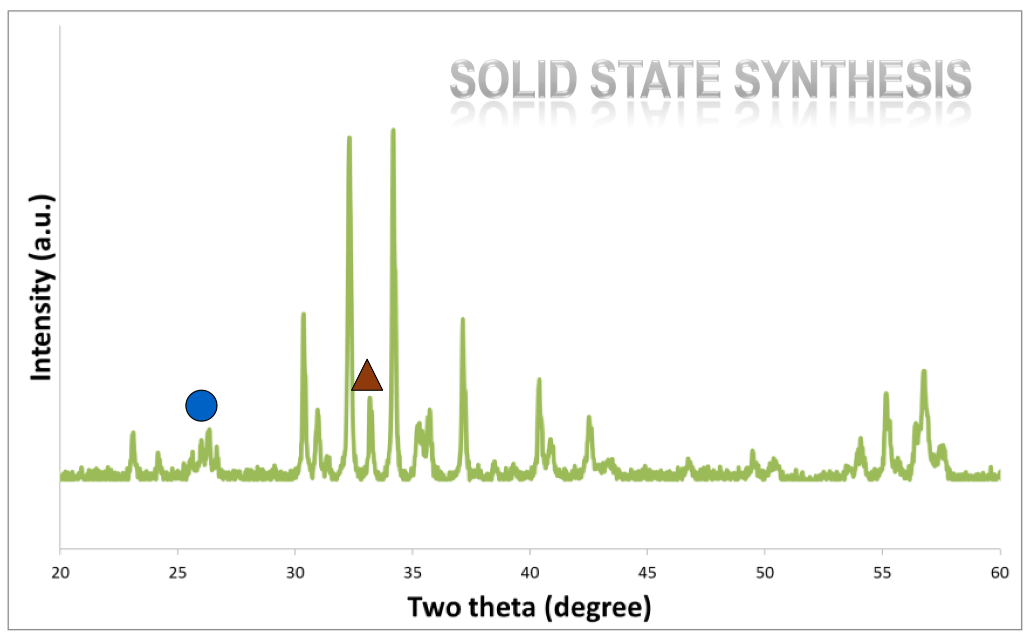


Printed antenna with diameter 31.5 mm

Material synthesis

Barium-Strontium M-type hexaferrites: $Ba_{0.75}Sr_{0.25}Fe_{12}O_{19}$ (BSFO)

RAW MATERIALS
Fe_2O_3, $BaCO_3$, $SrCO_3$
→ Wet Mixing → Drying
→ Calcination (900°C, 6 h)
→ **FERRITE POWDER**

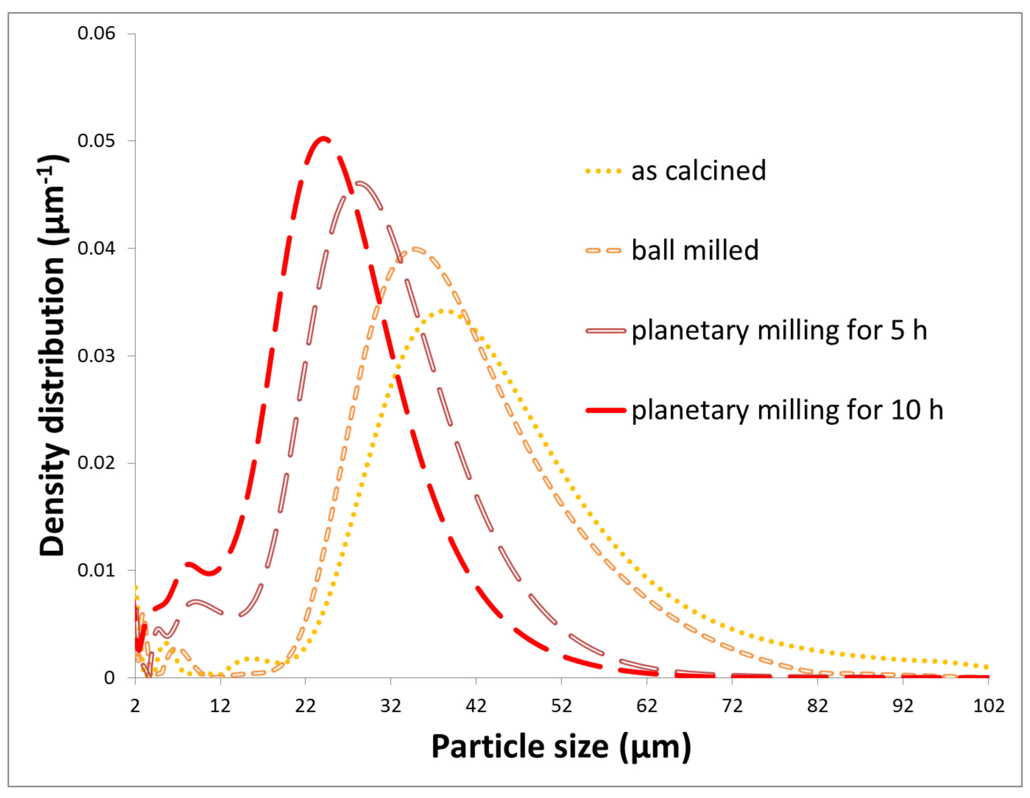


The powders after calcination doesn't shown a pure M-type hexaferrite phase, but some intermediate phase, such as BaO (●) and Fe_2O_3 (▲), are still presented

Key step: Powders Milling

The wet Planetary Milling (PM) has the double scope of:

- increase the powders homogeneity in terms of particle size and shape
- increase the powders reactivity reducing the average particle size



Powders	as calcined	ball milled	PM 5 h	PM 10 h
Mean particle size (µm) weighted on number	45	40	30	26
Mean particle size (µm) weighted on volume	51	44	33	28

Densification

Forming :

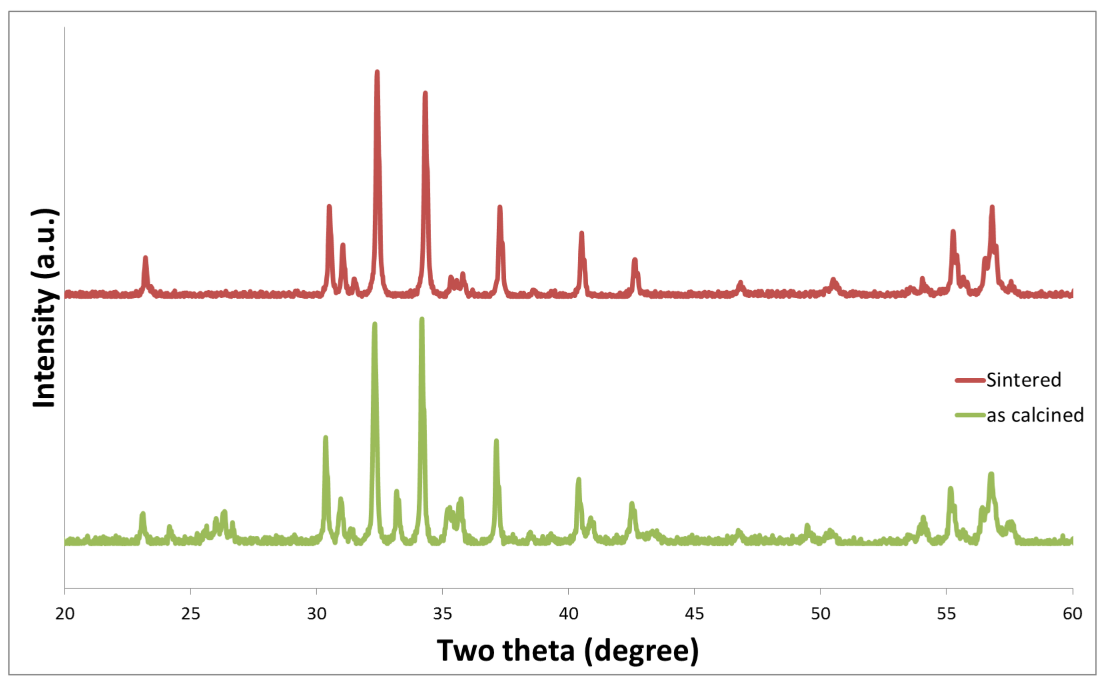
- linear pressing into disk
- cold isostatic pressing at 300 MPa

→ $\rho_{\%} \approx 56$ %

Sintering :

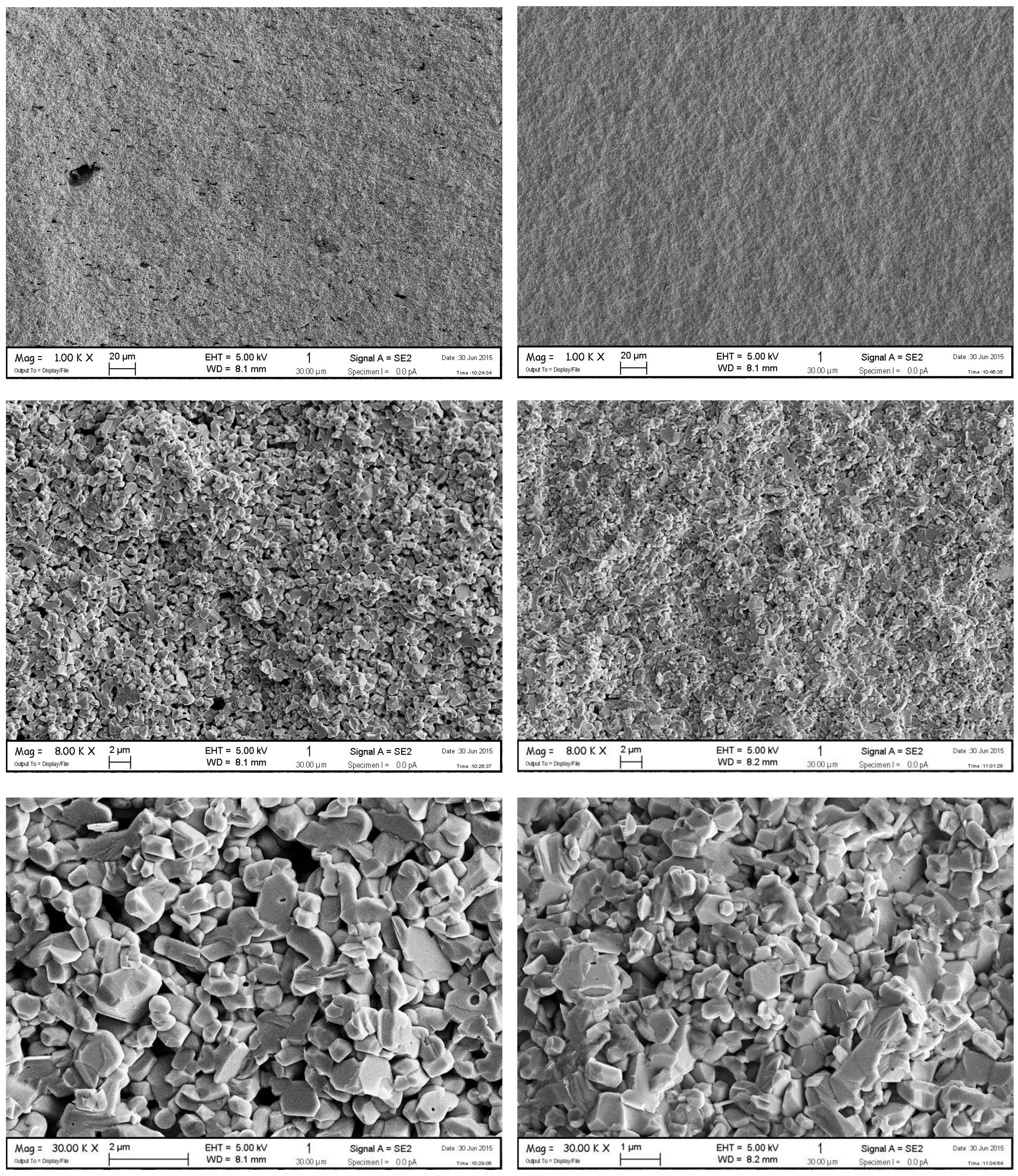
- Heating at 10 °C/min up to 1200 °C
- 1' soaking time

→ $\rho_{\%} > 90$ %



Microstructure

$Ba_{0.75}Sr_{0.25}Fe_{12}O_{19}$ powder calcined at 900°Cx 6 h sintered at 1200°Cx1min	$Ba_{0.75}Sr_{0.25}Fe_{12}O_{19}$ powder calcined at 900°Cx 6 h milled for 10 h sintered at 1200°Cx1min



$\rho_{\%} = 90$ %	$\rho_{\%} = 94$ %

Conclusion

Pure M-type hezaferrite was produced by conventional ceramic process.

The quite dense microstructures don't shown abnormal grains and the fine microstructures are characterized by a grain size distribution lower than 2 µm.

The milling treatment allows to avoid macropores and get a slightly finer microstructure